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# The state effect of depressive and anxiety disorders on big five personality traits

Julie Karsten<sup>a,\*</sup>, Brenda W.J.H. Penninx<sup>a,b,c</sup>, Hariëtte Riese<sup>a,d</sup>, Johan Ormel<sup>a</sup>, Willem A. Nolen<sup>a</sup>, Catharina A. Hartman<sup>a</sup>

<sup>a</sup> Department of Psychiatry, University of Groningen, University Medical Center Groningen, PO box 30 001, 9700 RB Groningen, The Netherlands

<sup>b</sup> Department of Psychiatry, VU University Medical Center, Amsterdam, The Netherlands

<sup>c</sup> Department of Psychiatry, Leiden University Medical Center, Leiden, The Netherlands

<sup>d</sup> Department of Epidemiology, Unit of Genetic Epidemiology, and Bioinformatics, University of Groningen, University Medical Center Groningen, Groningen, The Netherlands

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## ABSTRACT

**Background:** Neuroticism and extraversion are affected by depressive disorder state. Less is known about depressive state effects on conscientiousness, agreeableness and openness. Furthermore, state effects of anxiety disorders on personality have been far less studied than those of depressive disorder. Here, we aim to determine the extent of change in all five personality traits associated with the occurrence of or recovery from depressive and anxiety disorders.

**Methods:** Using the Composite International Diagnostic Interview (CIDI) at baseline and two-year follow-up, respondents from the Netherlands Study of Depression and Anxiety (NESDA) were divided into four groups: unaffected at baseline and follow-up, occurrence, recovery, and affected at baseline and follow-up. Personality change (NEO-five factor inventory) was examined in the occurrence and recovery groups relative to the unaffected and affected groups, respectively. Analyses were repeated, differentiating between (specific) depressive and anxiety disorders.

**Results:** We found small state effects of affective disorders on neuroticism, extraversion and conscientiousness. Corrected for each other, both depressive and anxiety disorders showed small state effects on neuroticism, but effects on extraversion and conscientiousness were mainly associated with depressive disorders.

**Conclusions:** State effects were small. When assessing neuroticism, the presence of both depressive and anxiety disorders should be taken into account, as both may independently increase neuroticism scores. However, when assessing extraversion and conscientiousness, depressive disorders but not anxiety disorders are likely to be of influence. Agreeableness and openness are influenced by neither.

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## 1. Introduction

The stability of personality traits has been subject to debate. One of the most prominent personality models is the Five-Factor Model of Personality (McCrae and Costa, 1996), which distinguishes five higher order traits: neuroticism, extraversion, conscientiousness, agreeableness and openness. Originally these traits were assumed to be exclusively biological in origin, to be unaffected by effects of the environment, and to mature until early adulthood and from then on to remain stable over time (McCrae and Costa, 1999; Terracciano et al., 2010). However, there is some evidence that personality traits are susceptible to gradual change over time (Srivastava et al., 2003; Roberts et al., 2006), or, as shown recently, when suffering from a depressive episode (Costa et al., 2005).

\* Corresponding author. Tel.: +31 050 3610981; fax: +31 050 3681120.

E-mail address: [J.Karsten@umcg.nl](mailto:J.Karsten@umcg.nl) (J. Karsten).

Indeed, studies have found neuroticism to increase and extraversion to decrease during depressive episodes, either temporarily (the state effect; Griens et al., 2002; Ormel et al., 2004), or even permanently in some (the scar effect; Kendler et al., 1993), but not all (Shea et al., 1996; Ormel et al., 2004; Jylhä et al., 2009) studies. While most studies focused on change in neuroticism (Ormel et al., 2004) and sometimes change in extraversion (Jylhä et al., 2009), less is known about changes in conscientiousness, agreeableness, or openness, although some studies have found them to be stable during a depressive episode (Harkness et al., 2002; Malouff et al., 2005; Morey et al., 2010). Also, compared to depression, change in personality in association with occurrence of or recovery from anxiety disorders has been far less studied (Bienvenu and Brandes, 2005). There is limited evidence that neuroticism decreases and extraversion increases when anxiety symptoms ameliorate in patients with panic disorder and agoraphobia (Reich et al., 1986) as well as in patients with depressive disorder (Jylhä et al., 2009).

Rarely have depressive and anxiety disorders been studied together in their association with change in personality. However, depressive and anxiety disorders often co-occur, therefore, the association of either depressive disorders or anxiety disorders with change in personality may be confounded by the other when studied separately.

In order to study the association of change in personality trait scores with change in depressive and anxiety disorders, longitudinal within subject designs are needed. In this study using baseline and 2-year follow-up data from a large longitudinal cohort study, we will investigate the association of change in personality trait scores with the onset of and the recovery from depressive and anxiety disorders, known as the state effect. The aim of our study is to determine the extent of change in all five personality traits associated with the occurrence of or recovery from depressive and anxiety disorders. Based on the existing literature, we expect the change in neuroticism and extraversion trait scores to be associated with the occurrence of and recovery from both depressive and anxiety disorders.

## 2. Methods

### 2.1. Sample

Data are from an 8-year longitudinal cohort study, the Netherlands Study of Depression and Anxiety (NESDA) on the predictors, course and consequences of depressive and anxiety disorders. Depressive disorders under study are Major Depressive Disorder (MDD) and Dysthymia (Dys), anxiety disorders under study are Social Phobia (SP), Panic Disorder (PD), Agoraphobia (AGO) and Generalized Anxiety Disorder (GAD). A general exclusion criterion was the presence of a clinical diagnosis of major psychiatric disorders other than depressive or anxiety disorder (e.g. psychosis, bipolar disorder, severe addiction disorder). Assessments consisted of face-to-face interviews with additional data collection by means of written questionnaires. NESDA recruited respondents from three different settings, i.e., general population ( $n = 564$ ), primary care ( $n = 1610$ ), and mental health organizations ( $n = 807$ ), resulting in a total of 2981 respondents. The study protocol was approved centrally by the Ethical Review Board of the VU University Medical Center and subsequently by local review boards of each participating center. After full verbal and written information about the study, written informed consent was obtained from all participants. This research was conducted in accordance with the Declaration of Helsinki. For more information on NESDA, its rationales and methods, see Penninx et al. (2008).

Of the 2981 respondents in NESDA, 2596 (87.1%) participated in the 2-year follow-up interview. Non-response was significantly higher among those with younger age, lower education, non-north European ancestry and depressive disorder, but was not associated with gender or anxiety disorder (Lamers et al., 2011). Of the remaining 2596 respondents, 2470 completed the personality questionnaires required for the current study. For statistical analyses, missing values were imputed using multiple imputation by means of Predictive Mean Matching based on all variables in our analyses (i.e., gender, age, CIDI diagnoses, NEO-FFI personality scale scores, BAI total scores, and IDS-SR<sub>30</sub> total scores), in SPSS 18. We used five sets of imputed data. Based on affective disorder status at baseline and two-year follow-up, the sample was divided into four groups: (1) unaffected, i.e. no disorder on baseline and two-year follow-up; (2) occurrence, i.e. no disorder on baseline, disorder on two-year follow-up; (3) recovery, i.e. disorder on baseline, no disorder on two-year follow-up; (4) affected, i.e. disorder on baseline and two-year follow-up. Details on these groups following imputation will be provided further below.

### 2.2. Measures

#### 2.2.1. Affective disorder status

The presence (yes/no) of depressive (MDD, Dys) or anxiety (SP, PD, AGO, GAD) disorder at baseline and two-year follow-up were assessed using the depression and anxiety sections of the Composite International Diagnostic Interview (CIDI, lifetime version 2.1; World Health Organization, 1997). The CIDI is a highly structured interview, designed to provide diagnoses according to both the International Statistical Classification of Diseases and Related Health Problems (ICD) and the DSM-IV and to be administered by laypersons. It is a highly reliable and valid instrument for assessing depressive and anxiety disorders (Wittchen, 1994). The interviews were performed and taped by clinical research assistants who had undergone one week of intensive training by a certified CIDI trainer.

#### 2.2.2. Personality

Personality at baseline and two-year follow-up was assessed using the NEO-five factor inventory (NEO-FFI), a 60-item personality questionnaire measuring five personality domains: neuroticism, extraversion, agreeableness, conscientiousness, and openness to experience (McCrae and Costa, 1996). The NEO-FFI has been found to have adequate internal and temporal reliability (both ranging from .75 to .87 across scales; Murray et al., 2003).

#### 2.2.3. Covariates

Age and gender were included as basic socio-demographic covariates, as they have been found to be related to both psychopathology (Ansseau et al., 2008) and change in personality (Srivastava et al., 2003). Also, we corrected for depressive symptom severity using the Inventory for Depressive Symptoms - Self Report (IDS-SR<sub>30</sub>; Rush et al., 1986) and anxiety symptom severity using the Beck Anxiety Inventory (BAI; Beck et al., 1988). Covarying baseline depression and anxiety severity removes a priori differences in symptom severity, thus focussing our analyses on stability versus change from baseline onwards.

### 2.3. Statistical analyses

First, we assessed whether there were any changes in personality traits between baseline and two-year follow-up. For this analysis, we used paired sample *t*-tests.

Second, to more specifically examine if change in personality trait scores is associated with the occurrence of and recovery from affective disorder, we proceeded with specific comparisons between the affective disorder status groups using regression analysis. For each personality trait, change scores of the occurrence group were compared with those of the unaffected group and change scores of the recovery group with those of the affected group. To accomplish this, two contrast variables (Rosenthal et al., 2000) were included in these analyses, contrasting 1) occurrence of affective disorder with no affective disorder at baseline and two-year follow-up, and 2) recovery from affective disorder with affective disorder at baseline and two-year follow-up. In this and all following analyses imputed data were used in order to avoid biased estimates. Analyses on personality differences at baseline or follow-up were corrected for age, gender, baseline or follow-up depressive symptom severity, and baseline or follow-up anxiety symptom severity. As the amount of change between baseline and follow-up may depend on baseline trait scores, analyses on change in personality were corrected for baseline personality trait score. The five main analyses of change in personality were additionally corrected for age, gender, baseline depressive symptom severity, and baseline anxiety symptom severity.

**Table 1**  
Unaffected, occurrence, recovery, and affected groups per disorder.<sup>a</sup>

Group	Dys	MDD	SP	PD	Ago	GAD
Unaffected	2201	1485	1895	1933	2004	2110
Occurrence	158	200	149	118	93	116
Recovery	154	538	342	373	313	292
Affected	83	373	210	172	186	78
Total	2596	2596	2596	2596	2596	2596

<sup>a</sup> based on original, unimputed data.

Third, we aimed to determine which personality trait scores were more affected by change in depressive disorder status and which personality trait scores were more affected by change in anxiety disorder status. We repeated the five analyses on personality change described in the previous paragraph. Four contrast variables were included in these analyses, contrasting 1) occurrence of depressive disorder with no depressive disorder at baseline and two-year follow-up, 2) recovery from depressive disorder with depressive disorder at baseline and two-year follow-up, 3) occurrence of anxiety disorder with no anxiety disorder at baseline and two-year follow-up, and 4) recovery from anxiety disorder with anxiety disorder at baseline and two-year follow-up. Analysed simultaneously and correcting for the same covariates, we investigated the unique contribution to change in each personality trait.

Fourth, on a more exploratory basis, we investigated whether personality trait scores were affected by change in specific depressive and anxiety disorder statuses, i.e., Dys, MDD, SP, PD, AGO, or GAD. Analyses were repeated, using the same covariates, now separately contrasting changes per disorder, thus resulting in twelve predictor contrasts.

### 3. Results

#### 3.1. Group characteristics

The total sample consisted of 2981 respondents (33.6% male; age  $41.9 \pm 13.1$  years) at baseline. Of these respondents, the

unaffected group consisted of 1017 respondents (35.8% male; age  $42.6 \pm 14.0$  years), the occurrence group of 160 respondents (25.0% male; age  $42.0 \pm 13.4$  years), the recovery group of 608 respondents (34.0% male; age  $40.5 \pm 12.7$  years), the affected group of 811 respondents (33.2% male; age  $42.3 \pm 12.0$  years), and 385 respondents (31.7% male; age  $41.0 \pm 12.9$  years) of which group membership could not be determined because of missing values at follow-up. When taking only depressive disorders into account, the unaffected group consisted of 1454 respondents (34.8% male;  $42.3 \pm 13.7$  years), the occurrence group of 196 respondents (26.5% male;  $42.7 \pm 13.0$  years), the recovery group of 516 respondents (32.4% male;  $40.3 \pm 12.5$  years), the affected group of 430 respondents (36.0% male;  $42.8 \pm 11.7$  years), and the undetermined group of 385 respondents (31.7% male; age  $41.0 \pm 12.9$  years). Similarly for anxiety disorder, 1353 (35.6% male;  $42.3 \pm 13.7$  years) were unaffected, 168 (27.4% male;  $41.2 \pm 13.0$  years) had an occurrence, 532 (32.7% male; 41.4 years) recovered, 543 (32.8% male;  $42.0 \pm 12.2$ ) were affected by an anxiety disorder, and 385 (31.7% male; age  $41.0 \pm 12.9$  years) were undetermined. For more detailed information on group sizes per disorder, see Table 1. In order to make use of all available data, analyses were performed using imputed data. After imputation, for affective disorders in general, the unaffected, occurrence, recovery, and affected group consisted of 1048, 232, 702, and 999 respondents, respectively. For depressive disorders only, the unaffected, occurrence, recovery, and affected group consisted of 1557, 266, 640, and 518 respondents, respectively, and for anxiety disorders only, the unaffected, occurrence, recovery, and affected group consisted of 1435, 241, 664, and 641 respondents, respectively.

#### 3.2. Change in personality trait scores

Personality at baseline and 2-year follow-up are shown in Table 2. Subjects in both the stable groups, i.e. the unaffected and affected, and the groups changing in affective disorder status, i.e. occurrence and recovery, showed changes in uncorrected personality trait scores over time (Table 2). Only extraversion and

**Table 2**  
Personality at baseline and 2-year follow-up by affective disorder and test of change in personality trait scores.

	Norms general population <sup>a</sup> M (SD)	Group	Baseline		2-year follow-up		p change <sup>c</sup>
			n <sup>b</sup>	Personality baseline M (SD)	n <sup>b</sup>	Personality follow-up M (SD)	
Neuroticism	31.1 (8.2)	Unaffected	1007	28.8 (7.7)	990	27.5 (7.1)	<.001
		Occurrence	160	35.9 (6.9)	152	37.3 (7.6)	.001
		Recovery	602	38.9 (7.0)	585	33.4 (7.1)	<.001
		Affected	803	42.4 (6.8)	764	40.6 (6.9)	<.001
		Unaffected	1007	41.0 (6.4)	990	41.1 (6.2)	.072
Extraversion	40.1 (6.6)	Occurrence	160	38.0 (6.1)	152	36.4 (6.7)	<.001
		Recovery	601	36.0 (6.5)	585	37.8 (6.6)	<.001
		Affected	803	33.0 (6.8)	764	33.7 (6.7)	<.001
		Unaffected	1007	44.3 (5.5)	990	44.8 (5.3)	.001
		Occurrence	160	42.3 (6.0)	152	41.4 (6.3)	.033
Conscientiousness	45.3 (5.6)	Recovery	602	41.3 (6.3)	585	42.8 (5.7)	<.001
		Affected	802	38.9 (6.6)	764	39.4 (6.4)	.006
		Unaffected	1007	45.1 (4.8)	990	45.5 (4.8)	.193
		Occurrence	160	44.5 (5.0)	152	44.8 (5.4)	<.001
		Recovery	602	43.8 (5.1)	585	44.6 (5.1)	.002
Agreeableness	44.1 (5.2)	Affected	802	42.7 (5.5)	764	43.0 (5.4)	<.001
		Unaffected	1007	38.4 (5.7)	989	37.0 (5.1)	<.001
		Occurrence	160	39.2 (6.0)	152	37.5 (5.2)	<.001
		Recovery	602	38.4 (5.9)	585	36.6 (5.3)	<.001
		Affected	801	38.4 (6.3)	764	36.7 (5.6)	<.001

Note. M = Mean, SD = Standard Deviation.

<sup>a</sup> Hoekstra et al. (1996).

<sup>b</sup> n may differ from original group size because of missing data on the NEO-FFI.

<sup>c</sup> Based on paired samples t-test on imputed data. These p-values are for illustrative purposes only and are uncorrected for baseline personality, symptom severity, age, gender, and multiple testing.



agreeableness in the unaffected group did not change significantly. However, groups varied in the direction and extent of change.

### 3.3. Change during occurrence of and recovery from affective disorder

To assess change in personality during the occurrence of affective disorder, we first compared change in personality between the occurrence and the unaffected group (Fig. 1). Compared to unaffected respondents, respondents with an occurrence of affective disorder were more neurotic at baseline (Fig. 2a) and became more neurotic over time ( $B = 2.15$ ,  $t(2973) = 10.69$ ,  $p < .001$ ,  $\eta^2 = .037$ ). Also, in addition to being less extraverted at baseline (Fig. 2b), respondents with an occurrence became less extraverted over time compared to the unaffected group ( $B = -.97$ ,  $t(2973) = 5.66$ ,  $p < .001$ ,  $\eta^2 = .011$ ). Additionally, respondents with an occurrence were less conscientious than unaffected respondents at baseline (Fig. 2c), and continued to become less conscientious over time ( $B = -.86$ ,  $t(2973) = 4.97$ ,  $p < .001$ ,  $\eta^2 = .008$ ), but the effect size of this association was negligible. Respondents with an occurrence were not less agreeable at baseline than unaffected respondents (Fig. 2d), nor did they become less agreeable over time ( $B = -.27$ ,  $t(2973) = 1.64$ ,  $p = .12$ ,  $\eta^2 = .001$ ). Compared to unaffected respondents, respondents with an occurrence of an affective disorder did not differ in openness to experience neither at baseline (Fig. 2e) or over time ( $B = -.13$ ,  $t(2973) = .91$ ,  $p = .37$ ,  $\eta^2 < .001$ ).

To assess change in personality associated with recovery from affective disorder, we compared change in personality of the recovery with the affected group (Fig. 1). Respondents recovered from an affective disorder did not differ in neuroticism from affected respondents at baseline (Fig. 2a), but became less neurotic over time ( $B = -2.30$ ,  $t(2973) = 15.00$ ,  $p < .001$ ,  $\eta^2 = .070$ ) although still more neurotic than unaffected respondents at follow-up (Fig. 2a). Furthermore, recovered respondents were more extraverted than affected respondents at baseline (Fig. 2b), and continued to become more extraverted over time ( $B = .89$ ,  $t(2973) = 7.89$ ,  $p < .001$ ,  $\eta^2 = .021$ ), but at follow-up were still less extraverted than unaffected respondents (Fig. 2b). In the same order, recovered respondents were more conscientious at baseline than affected respondents (Fig. 2c), and became more conscientious over time ( $B = .82$ ,  $t(2973) = 6.67$ ,  $p < .001$ ,  $\eta^2 = .015$ ), but less conscientious than unaffected respondents at follow-up (Fig. 2c). Finally, recovered respondents were not more agreeable at baseline

than affected respondents (Fig. 2d), but became more agreeable over time ( $B = .46$ ,  $t(2973) = 3.60$ ,  $p = .002$ ,  $\eta^2 = .004$ ), although with negligible effect size, and were not less agreeable than unaffected respondents at follow-up (Fig. 2d). Recovered respondents were not more open to experience at baseline than affected respondents (Fig. 2e) nor did they become more open to experience ( $B = -.06$ ,  $t(2973) = .54$ ,  $p = .59$ ,  $\eta^2 < .001$ ), and were not less open to experience than unaffected respondents at follow-up (Fig. 2e).

### 3.4. Unique contribution of depressive disorders and anxiety disorders to change

We further differentiated between depressive disorders and anxiety disorders in studying change in personality trait scores. Controlled for each other, change in neuroticism trait scores was associated with both the occurrence of and recovery from depressive disorders ( $B = 1.65$ ,  $t(2971) = 8.15$ ,  $p < .001$ ,  $\eta^2 < .022$ , and  $B = -1.78$ ,  $t(2971) = 9.31$ ,  $p < .001$ ,  $\eta^2 < .028$ , respectively), and the occurrence of and recovery from anxiety disorders ( $B = 1.58$ ,  $t(2971) = 7.98$ ,  $p < .001$ ,  $\eta^2 < .021$ , and  $B = -1.63$ ,  $t(2971) = 9.11$ ,  $p < .001$ ,  $\eta^2 < .027$ , respectively). That is, neuroticism trait scores increased with the occurrence of both depressive and anxiety disorders, and decreased with the recovery from depressive and anxiety disorders. Change in extraversion trait scores was more strongly associated with the occurrence of and recovery from depressive disorders ( $B = -.87$ ,  $t(2971) = 6.06$ ,  $p < .001$ ,  $\eta^2 < .012$ , and  $B = .87$ ,  $t(2971) = 5.69$ ,  $p < .001$ ,  $\eta^2 < .011$ , respectively), and to a lesser degree the occurrence of and recovery from anxiety disorders ( $B = -.54$ ,  $t(2971) = 2.91$ ,  $p = .008$ ,  $\eta^2 < .003$ , and  $B = .55$ ,  $t(2971) = 4.24$ ,  $p < .001$ ,  $\eta^2 < .006$ , respectively). However, the effect sizes for change in extraversion trait scores were negligible. Thus, extraversion trait scores decreased with the occurrence of depressive disorders, but hardly with the occurrence of anxiety disorders, and increased with the recovery from depressive disorders, but hardly with the recovery from anxiety disorders. Similar to change in extraversion trait scores, change in conscientiousness trait scores was more strongly associated with the occurrence of and recovery from depressive disorders ( $B = -.92$ ,  $t(2971) = 6.79$ ,  $p < .001$ ,  $\eta^2 = .015$ , and  $B = .70$ ,  $t(2971) = 4.82$ ,  $p < .001$ ,  $\eta^2 < .008$ , respectively), and to a lesser degree with the occurrence of and recovery from anxiety disorders ( $B = -.44$ ,  $t(2971) = 2.57$ ,  $p = .02$ ,  $\eta^2 < .002$ , and  $B = .43$ ,  $t(2971) = 2.97$ ,  $p = .01$ ,  $\eta^2 < .003$ , respectively). However, the associations of recovery from depressive disorders and of anxiety with change in conscientiousness were statistically significant, but of negligible effect size. Therefore, conscientiousness trait scores decreased with the occurrence of depressive disorders, but hardly with the occurrence of anxiety disorders, and hardly increased with the recovery from depressive or anxiety disorders. Consistent with the minimal change in agreeableness trait scores associated with the occurrence of and recovery from affective disorders in general, agreeableness trait scores decreased only negligible in effect size with the occurrence of depressive disorders ( $B = -.31$ ,  $t(2971) = 2.50$ ,  $p = .01$ ,  $\eta^2 = .002$ ) and only increased negligible in effect size with the recovery from anxiety disorders ( $B = .40$ ,  $t(2971) = 2.52$ ,  $p = .03$ ,  $\eta^2 = .002$ ). Change in openness to experience change scores was not significantly associated with either the occurrence of or recovery from depressive disorders, or the occurrence of or recovery from anxiety disorders.

### 3.5. Unique contribution of separate disorders to change

We further examined associations of the occurrence of or the recovery from specific depressive and specific anxiety disorders with change in personality. To differentiate between the disorders, we compared groups with different Dys, MDD, SP, PD, Ago, and GAD

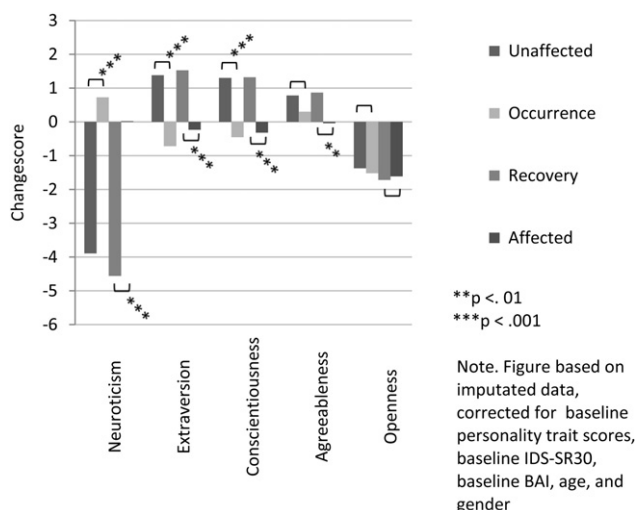
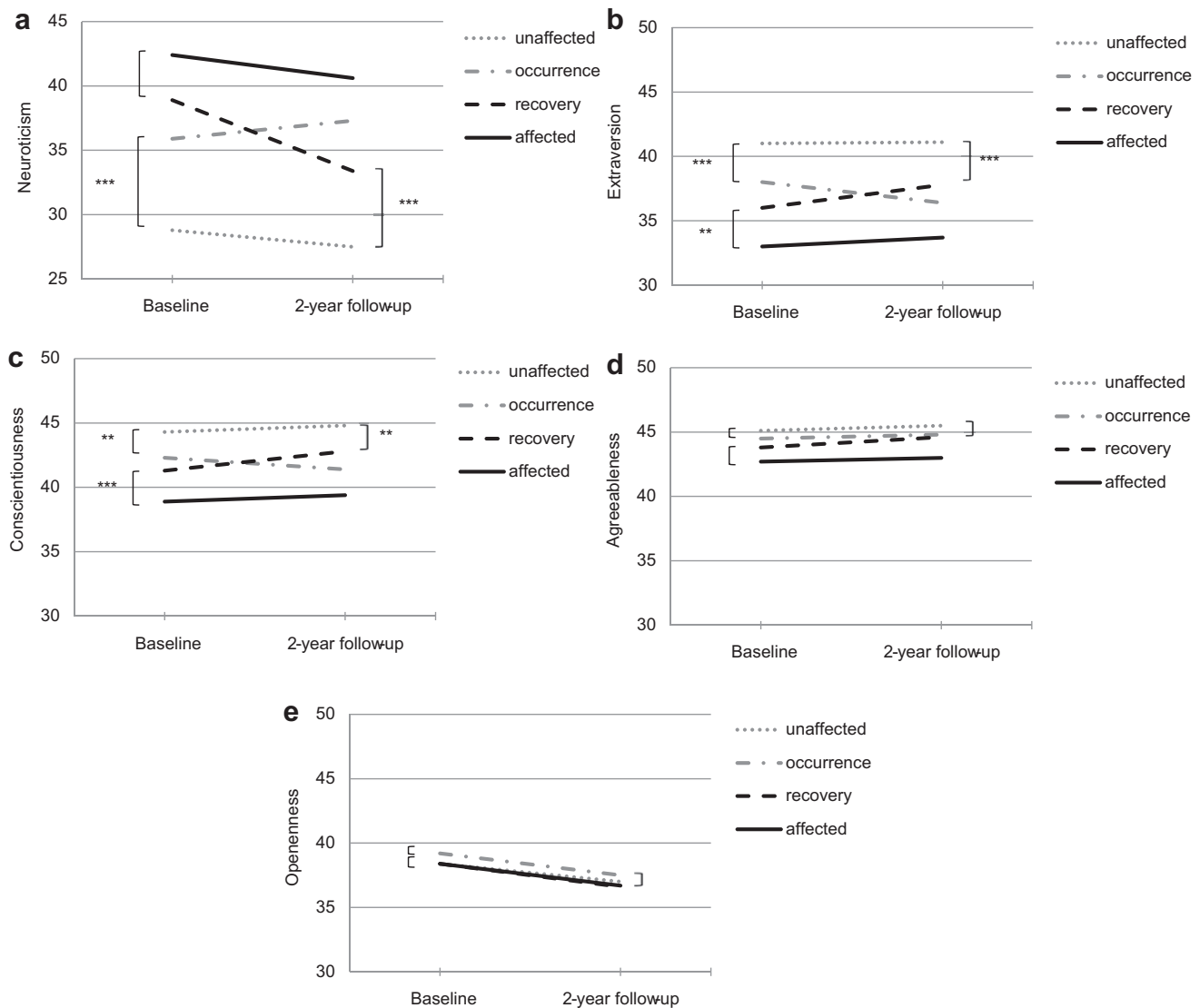


Fig. 1. Change in personality trait scores.



**Fig. 2.** a. Change in neuroticism by group. b. change in extraversion by group. c. Change in conscientiousness by group. d. Change in agreeableness by group. e. Change in openness by group. Note: Figures based on original, uncorrected data. Significance tests based on imputed data corrected for age, gender, IDS-SR30 and BAI; \*\* $p < .01$ ; \*\*\* $p < .001$ .

disorder statuses within a single analysis, thus controlling for each other.

An increase in neuroticism was associated with the occurrence of Dys ( $B = .67$ ,  $t(2963) = 3.42$ ,  $p = .001$ ,  $\eta^2 = .004$ , negligible effect), MDD ( $B = 1.65$ ,  $t(2963) = 8.09$ ,  $p < .001$ ,  $\eta^2 = .022$ , small effect), SP ( $B = 1.55$ ,  $t(2963) = 7.58$ ,  $p < .001$ ,  $\eta^2 = .019$ , small effect), and GAD ( $B = .97$ ,  $t(2963) = 3.20$ ,  $p = .01$ ,  $\eta^2 = .003$ , negligible effect). A decrease in neuroticism was associated with the recovery from MDD ( $B = -1.57$ ,  $t(2963) = 6.00$ ,  $p < .001$ ,  $\eta^2 = .012$ , small effect), SP ( $B = -.82$ ,  $t(2963) = 3.23$ ,  $p = .002$ ,  $\eta^2 = .004$ , negligible effect), PD ( $B = -1.04$ ,  $t(2963) = 4.28$ ,  $p < .001$ ,  $\eta^2 = .006$ , negligible effect), and GAD ( $B = -1.18$ ,  $t(2963) = 3.90$ ,  $p < .001$ ,  $\eta^2 = .005$ , negligible effect).

Extraversion decreased with the occurrence of Dys ( $B = -.62$ ,  $t(2963) = 3.33$ ,  $p = .002$ ,  $\eta^2 = .004$ , negligible effect), MDD ( $B = -.68$ ,  $t(2963) = 4.48$ ,  $p < .001$ ,  $\eta^2 = .007$ , negligible effect), SP ( $B = -.53$ ,  $t(2963) = 2.79$ ,  $p = .01$ ,  $\eta^2 = .003$ , negligible effect), and GAD ( $B = -.42$ ,  $t(2963) = 2.09$ ,  $p = .04$ ,  $\eta^2 = .001$ , negligible effect). Extraversion increased with the recovery from MDD ( $B = .57$ ,  $t(2963) = 3.00$ ,  $p = .01$ ,  $\eta^2 = .003$ , negligible effect), SP ( $B = .54$ ,  $t(2963) = 2.76$ ,  $p = .01$ ,  $\eta^2 = .003$ , negligible effect), and GAD ( $B = .66$ ,  $t(2963) = 2.90$ ,  $p = .004$ ,  $\eta^2 = .003$ , negligible effect).

A decrease in conscientiousness was associated with the occurrence of Dys ( $B = .56$ ,  $t(2963) = 3.10$ ,  $p = .004$ ,  $\eta^2 = .003$ , negligible effect), MDD ( $B = -.80$ ,  $t(2963) = 5.49$ ,  $p < .001$ ,  $\eta^2 = .010$ , small effect), and SP ( $B = -.45$ ,  $t(2963) = 2.63$ ,  $p = .01$ ,  $\eta^2 = .002$ , negligible effect). An increase in conscientiousness was associated with the recovery from MDD ( $B = .61$ ,  $t(2963) = 4.42$ ,  $p < .001$ ,  $\eta^2 = .007$ , negligible effect) and SP ( $B = .49$ ,  $t(2963) = 2.18$ ,  $p = .04$ ,  $\eta^2 = .002$ , negligible effect).

Agreeableness increased with the occurrence of MDD ( $B = -.26$ ,  $t(2963) = 2.07$ ,  $p = .04$ ,  $\eta^2 = .001$ , negligible effect), and decreased with the recovery from PD ( $B = -.49$ ,  $t(2963) = 2.64$ ,  $p = .01$ ,  $\eta^2 = .002$ , negligible effect) and GAD ( $B = .50$ ,  $t(2963) = 2.25$ ,  $p = .03$ ,  $\eta^2 = .002$ , negligible effect). Change in openness was not associated with the occurrence of or the recovery from any depressive or anxiety disorder.

#### 4. Discussion

In addition to a priori differences in personality, the occurrence of an affective disorder was associated with an increase in neuroticism trait scores and a decrease in extraversion and

conscientiousness trait scores. Similarly, recovery from affective disorders was associated with a decrease in neuroticism trait scores and an increase in extraversion and conscientiousness trait scores. Although personality trait scores normalized after recovery to levels less than one half standard deviation above normative means (Hoekstra et al., 1996), neuroticism scores of remitted respondents remained increased and extraversion and conscientiousness scores remained decreased compared to those of respondents unaffected by affective disorders.

These findings became more pronounced when differentiating between occurrence of or recovery from depressive disorders and anxiety disorders, respectively. Change in neuroticism trait scores was similarly associated with the occurrence of and recovery from depressive disorders as it was with the occurrence of and recovery from anxiety disorders. However, changes in extraversion and conscientiousness trait scores were more strongly associated with the occurrence of and recovery from depressive disorders, although minor associations were present for the occurrence of and recovery from anxiety disorders. In all analyses, change in agreeableness and openness to experience trait scores were marginally or not at all associated with the occurrence of or recovery from depressive or anxiety disorders. Final analyses evaluating occurrence and recovery of six affective disorders in relation to personality change left this conclusion intact, with the nuance that social phobia and GAD were to a small extent associated with extraversion, as was social phobia with conscientiousness.

Our study is one of the first to demonstrate a state effect of both depressive disorders and anxiety disorders on neuroticism trait scores. By including both change in depressive and anxiety disorders within a single analysis we avoided confounding effects of these highly comorbid disorders. In contrast to neuroticism, the state effects on extraversion and conscientiousness trait scores seem mainly driven by depressive disorders. These findings are in line with the earlier findings of Jylhä et al. (2009), who within patients with major depressive disorder found a state effect of anxiety on neuroticism, but not extraversion. As proposed in Clark and Watson's tripartite model (1991) or Mineka's integrative hierarchical model (1998), neuroticism (alternatively labelled Negative Affect) reflects a general distress component common to both depressive and anxiety disorders, while extraversion, or the more circumscribed trait of Positive Affect, is a trait mostly connected to depressive disorders. Studies on these models generally confirm the high association between Negative Affect and both depressive and anxiety disorders, and the high inverted association between Positive Affect and depressive disorders rather than anxiety disorders (Watson et al., 2005; Anderson and Hope, 2008; Rosellini and Brown, 2011). Our findings extend these findings by showing that neuroticism figures prominently in both depressive and anxiety disorders, not just predicting their onset, but also co-changing with both depressive and anxiety disorder states. Conversely, and consistent with the models above, our findings indicate that changes in extraversion are more strongly associated with changes in depressive disorder status than in changes in anxiety disorders status. It should be noted, however, that all found associations were small in effect, indicating a relative stability in persons with affective disorders, with small fluctuations associated with occurrence or recovery or disorder. Furthermore, as described by various authors, the distinction between neuroticism and extraversion in relation to anxiety and depression is not clear cut, as for instance extraversion has also been linked to social phobia (Brown et al., 1998; Mineka et al., 1998; Bienvenu et al., 2001, 2004; Rosellini and Brown, 2011) and agoraphobia (Bienvenu et al., 2001, 2004), while conscientiousness has been associated with general anxiety disorder (Rosellini and Brown, 2011). In this study, taking the occurrence of all other affective disorders into account, we

confirmed the relevance of extraversion for social phobia, here in relation to occurrence and recovery over time. Change in generalized anxiety disorder was also related to change in extraversion, and change in social phobia to change in conscientiousness, adding to the literature on personality and differentiation at the level of specific disorders.

A particular strength of this study is NESDA's large sample size and its longitudinal design, which enabled us to study change in personality trait scores in association with changing depression and anxiety statuses. Although common to all studies measuring personality, one limitation in the interpretation of our findings is that we cannot discriminate between two competing explanations of what state effects are. Found state effects may reflect true albeit temporary personality changes, as advocated by Clark and colleagues (2003), but it is possible that found effects are distortions in reporting due to the effects of affective disorders on self-perception and recall processes, also known as the mood-state distortion (Widiger et al., 1999; de Fruyt et al., 2006; Brown, 2007). This is a difficulty with currently no definitive solution available. A second limitation is that at this point, only data from two assessment points (baseline and 2-year follow-up) are available. This allows us to investigate state effects but not scar effects of depressive or anxiety disorders on personality. At follow-up we found differences in neuroticism, extraversion, and conscientiousness between recovered respondents and unaffected respondents. As this finding is not in line with the majority of studies that report no residual scar effects after recovery on top of pre-existing differences in personality (Shea et al., 1996; Ormel et al., 2004; Jylhä et al., 2009), we hypothesize that differences found in this study reflect a priori differences in personality traits and not residual scar effects.

In conclusion, neuroticism, extraversion, and conscientiousness are not only predispositions of affective disorders, but they appear to be also subject to change with onset and recovery. Depressive disorders had a state effect on neuroticism, extraversion and conscientiousness, and anxiety disorders mainly on neuroticism. However, state effects were small. Our study supports and extends the existing literature on neuroticism as a shared component of depressive disorders and anxiety disorders, and low extraversion and conscientiousness as a component of mainly depressive disorders.

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The funders of this study (as mentioned in the acknowledgements) were not involved in the study design; in the collection, analysis and interpretation of the data; in the writing of the report; and in the decision to submit the paper for publication.

### Declaration of interest

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